project WEB

Winter 2006

Connecting Projects WILD, WET and Learning Tree in New Hampshire

Global Climate Change: Myth or Reality?

Global climate change, in the most basic sense, is a change in climate. However, there is much more to it, as you will see in the main feature below. Is climate change really happening? The consensus among most scientists now is that global climate change *is* happening. They know it is happening because they have studied precipitation data and changes in weather patterns. Even in the Northeast, we have experienced climate changes. For example, the average temperature in the Northeast has increased by about 1.8° F since 1899, and we have seen intense rain and snow events. These are symptoms of climate change.

The important question is, "Do I really need to be concerned?" Yes, you do! There are potential impacts that could be serious for the health of humans and wildlife, for the environment and much more. Scientists and researchers believe that ski resorts, coastal communities, forests, foliage and coldwater fish could be some of the things in New Hampshire affected by global climate change.

This issue of Project WEB introduces you to global climate change and offers information on programs in the state that are already contributing to the effort to counter global climate change through technology, research and education.

IN THIS ISSUE

"You must be the change that you wish to see in the world."
~ Mahatma Gandhi

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New Hampshire
Fish and Game
Department

Climate Change and You

by Dr. Cameron Wake, UNH Institute for the Study of Earth, Oceans, and Space

Climate changes. It always has and always will. In the past, climate has changed for a number of reasons, including volcanic eruptions, variations in the sun's output, changes in the Earth's orbit around the sun, and the amount of dust and greenhouse gases in our atmosphere. What is unique in modern times is that human activities are now a significant factor causing climate to change. This is evident in the recent rise in key greenhouse gases, such as carbon dioxide (CO_2), in the atmosphere and in the recent increase in global temperatures in the lower atmosphere.

Antarctic ice core records, combined with modern day atmospheric measurements, clearly illustrate that atmospheric CO_2 levels today are higher than levels recorded over the past 420,000 years (Figure 1). Atmospheric CO_2 levels have risen 30 percent in the last 250 years since the beginning of the industrial

CLIMATE CHANGE continued on page 4

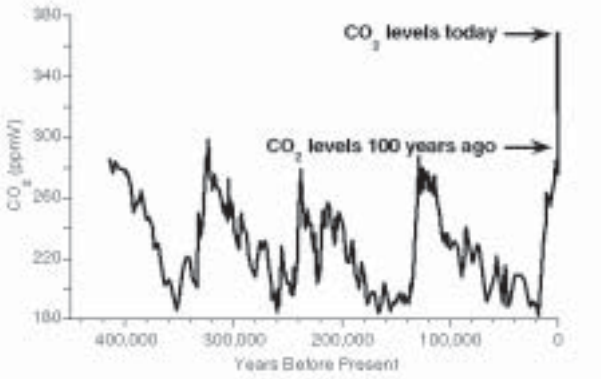

Figure 1. Carbon dioxide (CO2) levels in the atmosphere in parts-per-million by volume (ppmv) measured on ice cores from Antarctica and on top of Mauna Loa, Hawaii. Note that over the past 420,000 years as the Earth experienced 4 glacial cycles, CO2 levels never rose above 300 ppmv. Today CO2 levels are at 380 ppmv, higher than they have been for over 420,000 years. Data from Petit et al., (1999), Etheridge et al., 1996, and Worf and Keeling (2004).

Appalachian Mountain Club

Mountain Watch Program Helps Track Climate Change

The Appalachian Mountain Club (AMC) engages hikers of all ages in its citizen science program called Mountain Watch. Volunteers monitor air quality and plant phenology (response to seasonal variation) and contribute their findings to a database designed to track environmental trends and indicators of change over the long term. The main goals of the Mountain Watch program are to further our understanding of mountain ecosystems in relation to global change and to use hands-on tools in the outdoors to educate participants and foster environmental stewardship.

How does it work? Visibility is documented by hikers at set vistas in the White Mountains of New Hampshire by comparing the view stretching out in front of them to a photo of the same view on a clear day with peaks marked off in miles. Hikers also turn in photographs of views from their peak destinations. Ozone levels are estimated using an Ozone Detector Card provided with a datasheet. AMC researchers correlate the data collected with information on weather and ambient air quality.

Hikers also are asked to monitor the dates of alpine plant bloom and stages of deciduous tree leaf budding and senescence (leaf fall). Plants living the harsh alpine/sub-alpine ecosystems and lower slopes of the mountains can be used as local bioindicators of climate change. The program targets six common alpine plants, found in most alpine areas across northern New England. Volunteers are asked to report, observing from the trail, whether the plant is in flower or not using field identification guides. A more detailed phenological assessment method is also offered. Below the tree line, participants use tree guides and maps, identifying locations of specific tagged trees along trails and recording the stage of the tree's buds and leaves on the date of observation.

Mountain Watch data are compiled and summaries are posted on the AMC's interactive website, available to teachers, students, land managers, policy makers, researchers and hikers. Visit *www.outdoors.org/mountainwatch*. WEB

Activities Related to Articles in This Issue

Project WET suggests:

In the activity *Piece It Together*, students analyze and plot global temperature and precipitation distributions to determine climate patterns and how they influence human lifestyles.

Do you ever want to go on vacation when the weather is bad? Probably not, but in the activity *Wet Vacation*, students create travel brochures using annual precipitation and average temperature data, in the process researching the climatic conditions of their vacation destination.

In *The Thunderstorm*, students are engaged as they simulate the sounds of a storm through a whole body activity. Following the simulation, students will generate precipitation maps based on their findings.

Project Learning Tree Suggests:

In *The Global Climate*, using data collected from Mauna Loa, students will graph changes in atmospheric levels of carbon dioxide (CO_2) over a 46-year period and identify possible reasons for those changes. They will also learn about the relationship between CO_2 and the Earth's climate, and explore ways to reduce the amount of CO_2 they generate. (Note: this new activity is included in the revised 2006 PTL activity guide.)

Patterns of change are evident in the Earth's global systems. By exploring the issues of global climate change through *Our Changing World*, students will gain an understanding of how we must deal with the possibility of global environmental changes today.

Every year some 41 percent of all the energy we use in the U.S. is wasted needlessly. By cutting energy waste, we can reduce our demand for sources of new energy and reduce the amount of pollution we create. In *Waste Watchers*, your students can take a look at how they use energy in their own homes and how they can reduce the amount of energy they waste.

Project WILD suggests:

In the activity *Rainfall and the Forest*, middle school students work with state highway and vegetative maps to determine relationships among rainfall, vegetation and animal habitats.

On a simulated field trip, middle school students involved in the activity *Stormy Weather* put themselves in the place of a domestic or wild animal experiencing a storm.

In the activity *Time Lapse*, middle school students create and analyze a series of sketches depicting how the variety and quantity of wildlife changes as an ecosystem undergoes successional change.

New PLT Guide Available

Project Learning Tree has recently completed a revision of the Pre K-8 Activity Guide. While most of the activities remain the same, improvements include: enhanced and updated background and statistics, strengthened assessments, addition of literature and reading connections, addition of technology enhancements, notes on safety awareness, improved graphics and photos and more! There are also two new activities, *The Global Climate* and *Invasive Species*. For more information, contact Beth Lesure at (603) 226-0160, email *info@nhplt.org*, or visit *www.nhplt.org*. We look forward to sharing this new guide with you!

Spotlight on...

The Climate Change Research Center

Scientists at UNH study the Earth's changing climate

The Climate Change Research Center (CCRC) at the University of New Hampshire's Institute for the Study of Earth, Oceans, and Space (EOS) investigates atmospheric circulations and chemistry related to climate change. Center faculty, staff and students are involved in major field measurement programs ranging from local to global scales, including airborne emissions.

EOS is a multi-disciplinary research institute dedicated to obtaining a scientific understanding of the Earth system and its environment in space. CCRC personnel develop solutions to global geoscience problems through efforts involving numerical modelers, atmospheric chemists, geochemists, biogeochemists, statisticians, oceanographers and physicists.

CCRC scientists and staff are currently involved in three major climate programs: the joint UNH-NOAA (National Oceanic and Atmospheric Administration) AIRMAP project; the Northeast Center for Atmospheric Science and Policy; and an EPA-funded project involving fieldwork and mathematical modeling to study how regional climate change will influence future air quality in the Northeast. The largest of these programs, AIRMAP, is developing a detailed understanding of climate variability and the source of persistent air pollutants in New England using detailed atmospheric measurements from four New Hampshire air monitoring observatories. AIRMAP also includes a program that is studying the direct link between human health and regional air quality.

The center has a collection of small, regional ice cores from the Himalayas and the North American Arctic to look at local climate histories over the past 100 to 1,000 years. Also housed at CCRC is the National Ice Core Laboratory Science Management Office funded by the National Science Foundation. The management office coordinates field collection of major U.S. ice cores that represent hundreds of thousands of years of global climate history. These cores are made available to U.S. scientists across the country to study the Earth's past atmosphere and decipher climate records.

© COURTESY OF UNH CLIMATE CHANGE RESEARCH CENTER

Climate information is collected at the Mount Washington Observatory.

For further information on the CCRC and its programs, visit *www.ccrc.sr.unh.edu*. WEB

Article courtesy of David Sims, Science Writer, Institute for the Study of Earth, Oceans, and Space

Investigating Climate Change

With GLOBE Atmosphere and Phenology Measurements

The GLOBE Program (Global Learning and Observations to Benefit the Environment) is an international science and education program that connects teachers and students with the world through scientific investigations. Students take scientifically valid measurements in atmosphere, hydrology, soils, land cover and phenology (response to seasonal variations) and enter their data into the public GLOBE database. Scientists use the data to conduct their research.

Some atmosphere protocols that students can carry out to help monitor the climate are daily minimum, maximum and current temperature, surface temperature, clouds, contrails and precipitation. These are used by scientists to validate data acquired from satellites and help refine weather and climate prediction models. In addition, schools around the world tracking these measurements contribute to a long-term (10 years and going) database of how parameters are changing on a local to worldwide basis. These types of long-term, daily measurements supply data to help scientists and students explain if, how, where, and perhaps why, the climate is changing.

Three phenology protocols that are particularly interesting for New Hampshire students are budburst, and the rate and color changes of green-up and green-down. Tourists, businesses and recreation enthusiasts enjoy and use New Hampshire forests for hiking, camping, leaf-peeping, skiing, hunting, firewood, maple syrup, paper, Christmas trees, etc., and forests provide important wildlife habitat. Are our forests changing because of a shift in the climate? What is the relationship between precipitation and temperature and budburst, green-up and green-down? Students in New Hampshire can look for trends with these protocols!

For more information or to attend GLOBE training, visit *www.globe.gov* or contact Jen Bourgeault at (603) 862-4178 or *jen.bourgeault@unh.edu*.

WEB

CLIMATE CHANGE continued fom page 1

revolution. Two other important greenhouse gases have also risen over the past 250 years – methane (CH_4) has increased 150 percent while nitrous oxide (N2O) has increased by 15 percent. Why is this important for our climate? Greenhouse gases are an important component of our climate system. These gases serve to trap heat at the surface of the Earth, much the same way a blanket serves to keep you warm on those cold New Hampshire nights. In fact, without greenhouse gases, our planet would be 50° F cooler, on average. It is hard to imagine life as we know it if the all the water on our planet was frozen!

So, greenhouse gases CAN be a good thing. But there can be too much of a good thing. The rapid rise in greenhouse gases over the past 100 years is trapping additional heat in our atmosphere and causing the temperatures to rise to levels higher than they have been for the last 1,000 years. How do we know? Scientists working around the world have collected detailed records of past climate change by deciphering climate records stored in the annual layers of trees, corals, and glaciers, and by collecting historical and instrumental records of climate change. These records have been combined into a single record that documents temperature change over the past 1,000 years (Figure 2). Clearly, the last decade has been the warmest of the last millennium.

What about the last 100 years? Averaged over the entire globe, temperatures have increased about 2° F over the last 100 years, with considerable variability from year to year and decade to decade. However, the last 30 years have experienced a steady rise in temperatures. The Intergovernmental Panel on Climate Change (IPCC) has assembled a group of climate scientists to assess recent climate change and analyze the recent warming trends. Using a variety of tools, including well-documented global climate models (GCMs), the IPCC (2001) has concluded that there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities, primarily as a result of CO_2 emitted by the burning of fossil fuels and deforestation.

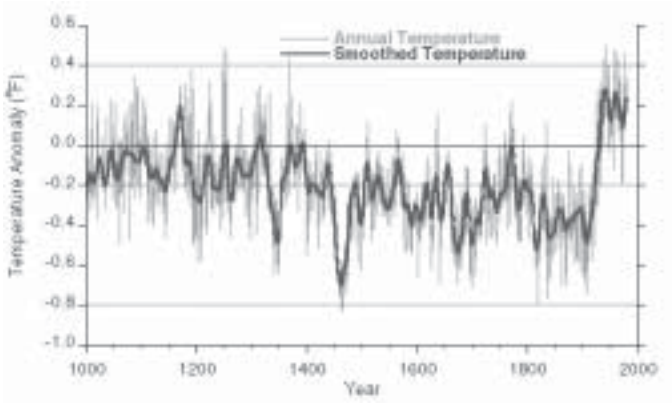

Figure 2. Temperature change over the last 1,000 years in the northern hemisphere as documented by a combination of tree-ring, ice core, coral, and instrumental records by Mann et al., (1999). Note that the recent few decades have been the warmest of the last 1,000 years.

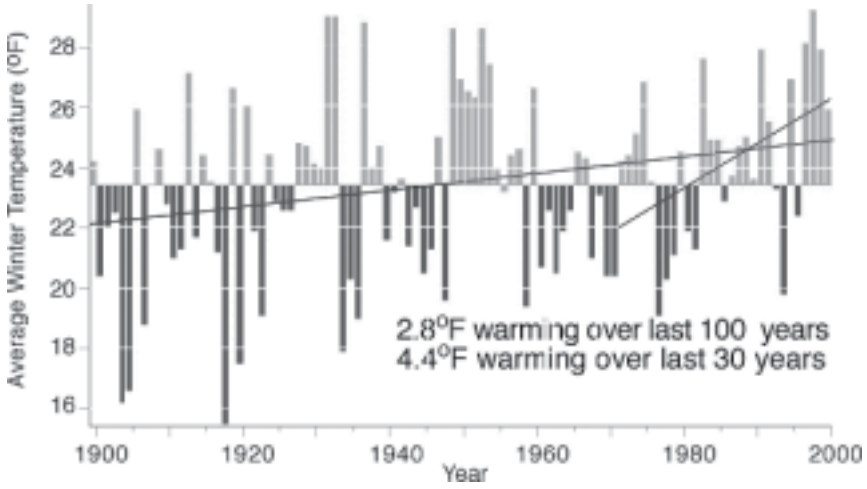

Figure 3. Changes in winter temperatures in the Northeast US over the last 100 years, derived from analysis of the US Historical Climatology Network Data. Figure from Wake and Markham (2005). Note the significant warming over the last 30 years. Data and more information is available online at: ***inhale.unh.edu/Climate/index.html****.*

What about New England? Over the past 100 years, an analysis of the best available meteorological data indicates that the region has also warmed about 2° F. There has been an increase in the rate of warming over the last 30 years, and this warming trend has been especially apparent in winter, where we have observed a temperature increase of 4.5° F (Figure 3). This has been accompanied by earlier breakup of lake ice in the spring, a decrease in snowfall, a decrease in the number of days with snow on the ground and earlier spring bloom dates for lilacs, apples and grapes. Clearly, our climate is changing and the rate of change has increased.

What does the future hold? Projections of future climate change depend fundamentally on how much greenhouse gas we put into the atmosphere through the burning of fossil fuels and deforestation. If we continue with our reliance on oil and coal to provide our energy, CO_2 will continue to rise and, by the end of the century, the GCMs indicate that average global temperatures will increase from 4-9° F, and sea level will rise from 1-2 feet by 2100 AD. These changes will affect every sector of our economy and will affect our health and quality of life. However, we do not need to follow this path. In fact, by improving the efficiency with which we use energy (by, for example, building more energy-efficient buildings and driving fuel-efficient cars), by producing more of our energy from renewable resources (wind, water, wood, solar) and by taking a sustainable approach where we balance the needs of our ecosystem and climate system, our economic system and human well-being, we can map a path to a prosperous future while maintaining our quality of life and limiting the amount of human-induced climate change.

References:

Etheridge, D.M., L.P. Steele, R.L. Langenfelds, R.J. Francey, J.-M. Barnola, and V.I. Morgan. 1996. Natural and anthropogenic changes in atmospheric CO2 over the last 1000 years from air in Antarctic ice and firn. *Journal of Geophysical Research* 101:4115-4128.

Keeling, C.D. and T.P. Whorf. 2004. Atmospheric CO2 records from sites in the SIO air sampling network. In Trends: A Compendium of Data on Global Change. Oak Ridge, TN: Carbon Dioxide Information Analysis Center.

Mann, M.E., R.S. Bradley, and M.K. Hughes, Northern Hemisphere temperatures during the past millenium: inferences, uncertainties, and limitations, *Geophysical Research Letters*, *26* (6), 759-762, 1999.

Petit J.R. et al. 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. Nature 399:429-436.

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DataStreme Atmosphere Course for Teachers

By Marsha Rich,
DataStreme Atmosphere Local Implementation Team Leader

With its seasonal, daily and sometimes hourly changes, weather is a perennially fascinating topic for all New Englanders. Its variability, excitement and relevance make it a great vehicle for enhancing students' interest in science. As with all science, meteorology, which is the study of weather and the atmosphere, begins with making observations, analyzing and interpreting data, developing predictions, and then evaluating the accuracy of those predictions. Direct quantitative and qualitative weather observations can be made by students of all ages, and real-time weather data is readily available through the Internet. Studying weather as it happens is both relevant and exciting and can foster better understanding of science, math, geography, writing and the social sciences. Educators seeking to enhance their use of current weather in the classroom have an exciting resource available to them, the *DataStreme Atmosphere* project.

DataStreme Atmosphere is a nationally implemented teacher-enhancement project of the American Meteorological Society (AMS). It consists of a 13-week course that focuses on the study of the atmospheric environment through the use of electronically transmitted weather data and learning materials. The course uses a textbook, investigation manual, and website that delivers current weather products and learning activities. The course is facilitated through local implementation teams, consisting of educators and professional meteorologists. In a typical semester, six to eight teachers take the course through each local DataStreme implementation team. Most coursework is completed independently, with three group meetings during the semester. Each participant is mentored by one of the team members, who provides direct feedback to the participant. *DataStreme Atmosphere* offers real experiences that demonstrate the value of computers and electronic access to time-sensitive information, as well as scientifically accurate, up-to-date and instructionally sound resource materials for teachers and students.

AMERICAN METEOROLOGICAL SOCIETY
DataStreme Atmosphere

DataStreme Atmosphere is currently offered in New Hampshire and is anticipated to be offered again in the fall of 2006. The three group meetings will take place on weekday afternoons at Plymouth State University. Tuition is covered by the AMS, but participants are responsible for the $100 cost of materials, which include the DataStreme textbook, investigations manual, supplementary books, several teaching manipulatives and a NOAA weather radio receiver. Participants who complete the course will earn three graduate credits through the State University of New York.

If you would like more information about DataStreme Atmosphere or are interested in becoming a participant for the next semester it is offered, visit the project's website at *www.ametsoc.org/amsedu/dstreme*. For additional information about the next session of the course in New Hampshire or for a printed application, contact Marsha Rich, DataStreme Atmosphere Local Implementation Team Leader, at *marshar@aol.com* or (603) 798-4267. WEB

RESOURCES AND WEB CONNECTIONS

UNH Climate Change Resources
eos-webster.sr.unh.edu/climate_change.jsp

Cool Solutions to Global Warming: 24 Success Stories from the Northeast
www.cleanair-coolplanet.org/solutions/index.php

Global Warming International Center
www.globalwarming.net/

New England Science Center Collaborative on Global Climate Change
www.nescc.info/index.php

Union of Concerned Scientists – Citizens and Scientists for environmental solutions
www.ucsusa.org/

Website Guide To Global Climate Change
www.epa.gov/region01/eco/cchange/guide.html

Real Climate
www.realclimate.org

Indicators of climate change in the Northeast
inhale.unh.edu/Climate/index.html

Intergovernmental Panel on Climate Change (IPCC)
www.ipcc.ch/

Human Impact on Land Surface – article from the UNH Campus Journal
www.unh.edu/news/campusjournal/2005/september/092805impact.html

Upcoming Projects Workshops

March 18 – Project WET at Sunset Valley Girl Scouts in Gorham from 9 a.m. – 3 p.m. For more information, contact Jessica Brock at (603) 271-4071 or **jbrock@des.state.nh.us** or visit **www.des.nh.gov/wet/wetsched.htm** to register.

May 20 – WOW! The Wonders of Wetlands, location and time to be determined. For more information, please contact Jessica Brock at (603) 271-4071 or **jbrock@des.state.nh.us**.

New Hampshire Environmental Educators Annual Meeting.

Reserve March 8 (rain date March 9) to attend the NHEE annual meeting. This event provides an opportunity to network with other educators and natural resource professionals while engaging in workshops and presentations focused on sustainability. For more information, please visit **www.neeea.org/nh** or contact Beth Lesure at (603) 226-0160 or **info@nhplt.org**.

Calling All Interpreters

The National Association of Interpretation Region 1 annual spring conference is scheduled for March 27-29 at the Sandy Point Discovery Center in Stratham, N.H. For a workshop schedule and registration information, contact Mary Goodyear, N.H. Fish and Game, at **mgoody@ncia.net** or (603) 846-5108.

Discover WILD New Hampshire Day

Saturday, April 22, 9 a.m. to 3 p.m. A fun day of hands-on, educational activities for the whole family at the New Hampshire Fish and Game Department headquarters at 11 Hazen Drive in Concord. Free admission. For more information, call (603) 271-3211 or visit the Fish and Game website at **www.wildlife.state.nh.us**.

Keene Fourth and Fifth Graders Invited to Water Festival

The New Hampshire Drinking Water Week Coalition will hold its 14th annual Drinking Water Week Festival on Wednesday, May 3, at the Cheshire Fairgrounds in Swanzey. Local fourth and fifth grade classes are invited to attend at no cost. The festival includes a theatre performance, hands-on water activities, the state science fair, and much more. For more information, contact Jessica Brock at (603) 271-4071 or **jbrock@des.state.nh.us**.

A Walk in the (Urban) Forest

NHPLT sponsors this workshop for teachers interested in organizing outdoor field trips for their students to investigate their schoolyard and local (urban) forest. The goal of the Walk in the Forest program is to provide teachers and their students an opportunity to learn about trees, forests, the environment, and how professionals and tree farmers care for New Hampshire's forests and natural resources. Workshops will be held on Saturday, May 13, in Portsmouth and Nashua, and on Tuesday, July 18, in Manchester and Keene. For more information, contact Beth Lesure at (603) 226-0160 or **info@nhplt.org**.

2005 Envirothon Set for May 16

High school classes are invited to participate in the 2006 New Hampshire Envirothon, a high school competition designed to build knowledge of water resources, forests, soils, wildlife and current environmental issues. This year's theme is "Water Stewardship in a Changing Climate." For more information, contact Herb Vadney at (603) 279-3436 or visit **www.envirothon.org**.

SERESC, PLT, WET, & WILD Workshop

This five-day professional development opportunity (three days during the last week of June and two days at the end of July) for science teachers will be held in Concord. The work of the institute will be organized around change. Topics will include wetlands and forest succession, wildlife patterns, biodiversity and much more! For more information, contact Sandy Kent at (603) 529-3364 or **kentss@gsinet.net** or visit **www.nhplt.org**.

Watershed Ecology – Summer Course for Science Teachers and Community Leaders

Watershed Ecology is an undergraduate and graduate-level summer program geared to science educators and community leaders. Coordinated by staff from N.H. Fish and Game, the course offers techniques for applying science in real-world situations. Each day, specialists focus on a different aspect of watershed ecology. Hands-on, experiential learning is emphasized in both field and classroom settings. The course can be taken for 2 credits from the UNH Division of Continuing Education or as a non-credit course. Two-week course offered mid-summer, 8:30 a.m. – 4 p.m., Monday – Friday, at Bow High School. Contact Fish and Game's Aquatic Resources Education staff at (603) 271-3212.

Curriculum Connections through Schoolyard Investigations

August 14-18: The New Hampshire Education and Environment Team invites educators of grades K-8 to a five-day professional development institute designed to incorporate the newly proposed science frameworks. Held at Barry Conservation Camp in Berlin, N.H. Participants will have an opportunity to design an interdisciplinary schoolyard or community investigation tailored to their school and curriculum. All meals, lodging, instruction, manuals and other materials for projects WET, WILD, Learning Tree, HOME and the GLOBE Program are included in the $150 registration fee. Four graduate credits are available from Plymouth State University for an additional fee. For more information about the institute and how to register, contact Marilyn Wyzga at N.H. Fish and Game, **mwyzga@wildlife.state.nh.us** or (603) 271-3211.

Earth & Sky Radio Show Connects to PLT Activities

EarthCare and the Earth & Sky Radio Show feature short informational stories about endangered animals, the climate, forests, the atmosphere, oceans, conservation, and many other environmental topics. The site lists PLT activities teachers can use to further student exploration of these topics. Transcripts for each show provide ideas for book reports and other projects and can help develop reading comprehension skills while sparking an interest in science. EarthCare and the Earth & Sky Radio Program are available at **www.earthsky.org**.

Action Grants Available

Got a schoolyard habitat project? Then apply for a Homes for Wildlife Action Grant funded by the Conservation License Plate revenue through the Nongame and Endangered Wildlife Program of the N.H. Fish and Game Department. The program provides $300-$600 grants to help initiate habitat projects. Qualifying projects will 1) directly benefit wildlife; 2) involve students in planning and implementation; 3) make connections with your curriculum; and, 4) be sustainable for the long term. Grant deadlines are February 15 and November 15, 2006. Contact: Marilyn Wyzga, Project HOME coordinator, at (603) 271-3211 or **mwyzga@wildlife.state.nh.us**.

ON THE H.O.M.E. FRONT

School Microclimates

by Marilyn Wyzga

mi·cro·cli·mate (mī´-krō-klī´-mit) *n.* The climate of a small, specific place within an area, as contrasted with the climate of the entire area.

Microclimate is the local climate on a small site, such as a woodland, garden, park or small area of a city, where the typical weather (temperature, rainfall, wind or humidity) differs from the surrounding area. Many slightly different microclimates together make up the climate for a town, city or woodland. Significant differences can exist between the climates of two neighboring areas. For example, your town may be warmer than the surrounding countryside, and your school woodland cooler, darker and less windy than open ballfields.

The variety of microclimates on your school site provides ample opportunity to explore the effects of climate and hypothesize about potential impacts of climate change. You might also study your site's microclimates while designing a habitat area or native garden space. Understanding the different elements of climate that affect your landscape will help you make the best use of this valuable resource.

In the Zone

If a microclimate is the climate of a small, specific place as contrasted with the climate of the entire area, then the climate of the entire area is the "macroclimate." This is indicated by where a region lies in the USDA Plant Hardiness Zone (or "zone" for short).

There are 11 USDA Plant Hardiness Zones in the U.S. and southern Canada, each defined by a 10° F difference in the average annual minimum temperature. The higher the number, the warmer the climate for gardening in that zone. Seeds and nursery plants come labeled with their USDA Plant Hardiness Zone, meaning the zone in which you'll be most successful growing them; most gardening books come equipped with a zone map.

Working with Microclimates

Your school site's microclimate may receive more sun, shade, wind, rain, snow, moisture or dryness than average local conditions. If your school is located on a sunny southern slope, it may have a warm microclimate, even though you live in a cool region. Nearby bodies of water may increase your site's humidity or decrease its air temperature.

Pockets on your site may also exhibit these variations, which will determine what plants may or may not grow in your landscape. Your students could experiment with growing plants not suited to their region's climate by learning how to exploit microclimates. For instance, sunny nooks sheltered from harsh winds and frosts (such as at the base of a sun-baked wall) make excellent plots for experimenting with plants otherwise considered too tender for our region. In New Hampshire, which is largely zones 3-4, you can grow a plant that is supposedly hardy only to zone 6 in the microclimate of such a sunny, sheltered nook. By creating suntraps and diverting cold air with natural vegetation, trellises or walls, you can extend the growing season and minimize frosts, while learning about climate factors and plant needs.

The south-facing wall of South Londonderry School creates a warmer microclimate for this habitat garden; in turn, the vegetation shades and cools the building.

Northern Exposure

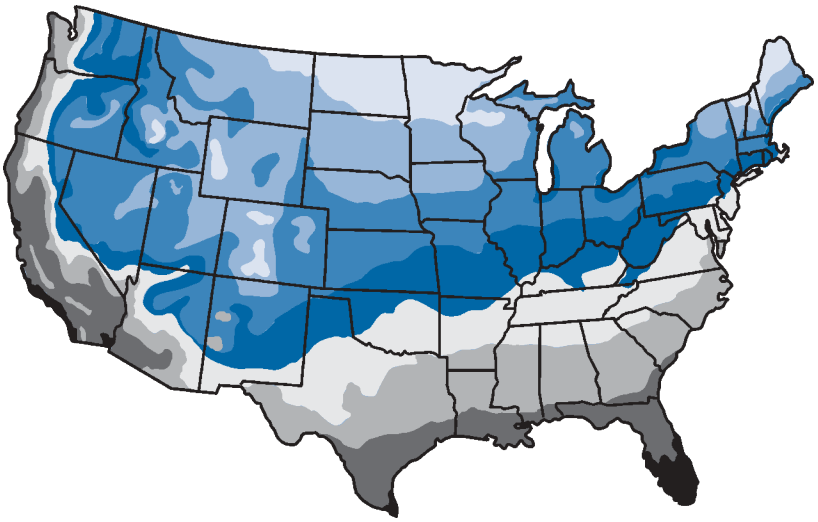
The U.S. can be roughly divided into four climatic regions: temperate, hot-arid, hot-humid, and cool (see the map at **www.eere.energy.gov**). New Hampshire crosses between the temperate and cool regions. Here, we experience moderate average temperatures that change significantly with the seasons. Winter and summer are of almost equal length, and neither is too extreme. Ample precipitation arrives as rain and snow. Summer sun tends to be strongest from the southeast to the southwest, and winter winds tend to blow from the northwest.

Slope plays a part in microclimate. A south-facing slope or aspect is exposed to more direct sunlight than opposite slopes and

HOME continued on next page

A World of Microclimates

There is a distinctive microclimate for every type of environment on the Earth's surface. In upland areas, warm, up-valley winds during the day and cool, down-valley winds at night create very distinctive microclimates. Precipitation amounts vary, with windward slopes receiving more rainfall. Coastal areas have land breezes and sea breezes that are generally mild during the winter months and cool in summer. Warm, onshore breezes may build up fog on the coastal fringe, as warm, moist air comes into contact with the cold land surface. Woodlands can be cooler and less windy than surrounding grasslands, with trees acting as a windbreak and incoming solar radiation filtered by leaves and branches.



APPROXIMATE RANGE OF AVERAGE ANNUAL MINIMUM TEMPERATURES FOR EACH ZONE

ZONE 3	-40°F to -30°F	ZONE 7	0°F to 10°F
ZONE 4	-30°F to -20°F	ZONE 8	10°F to 20°F
ZONE 5	-20°F to -10°F	ZONE 9	20°F to 30°F
ZONE 6	-10°F to 0°F	ZONE 10	30°F to 40°F

HOME continued from previous page

stays warmer longer; some plants prefer a sunny southern aspect. Others thrive in a northern or eastern exposure, where land sloping away from the sun is prone to longer shadows and cooler temperatures. Slope also affects ground temperature; cold air falls from uphill, while warm air will rise uphill at the end of the day.

When planning a habitat area or native garden, create a sketch map of your site, marking out the buildings, garden beds, trees and any other features. Then mark out microclimate features of the area, such as orientation of your site to the sun, prevailing wind, influence of nearby buildings, reflective surfaces (water and windows), spread and foliage type of any existing trees (dense or light foliage, deciduous or evergreen trees) and topography (slopes and dips).

Once you have all this on your plan, you'll be able to make decisions about what and where to plant. For example, you could trap warm air as it rises on a slope by creating windbreaks. Since clustered plants often raise the average air and soil temperature and humidity of an area, a sheltered position can reduce the severity of winter. Roof gardens, on the other hand, expose plants to more intense temperatures in both summer and winter, and require plants that can tolerate these extremes. You may even rethink how to use an open, sunny spot, as this type of area is perfect for a butterfly or vegetable garden. WEB

ACTIVITY! Visit the *Journey North* website at *www.learner.org/jnorth/tm/tulips/Microclimate.html* for a terrific activity on Exploring Microclimates. It includes field charts for student use.

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